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FILARIA CINGULA PARASITIC IN THE SKIN OF CRYPTOBRANCHUS ALLEGHENIENSIS *

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So far as I am aware the only worms reported to be parasitic in the skin of the members of the genus *Cryptobranchus* are an encysted *Bothriocephalus* larva found by Leuckart and a Nematode, *Filaria cingula*, mentioned by von Linstow. Both parasites infested *Cryptobranchus maximus*.

The description of *Filaria cingula* given by von Linstow is taken from a single specimen and is rather incomplete, nevertheless his specimen and a worm found by me in *Cryptobranchus allegheniensis* appear to have certain points in common. The most important difference is that *Filaria cingula* has a vulva whereas I have not yet been able to discover one in the worms from *Cryptobranchus allegheniensis*. My specimens are not as perfect as they might be so it is possible that further search will disclose the presence of a vulva. In the meantime, for the sake of conservatism, it may be best to consider the specimens as being specifically identical with *Filaria cingula*. It is worthy of note that the *Cryptobranchus maximus* in which von Linstow found *Filaria cingula* came from Japan whereas the host of the worms here under discussion is found in the Ohio river. In view of von Linstow's meager description some account of these parasites may be of value.

Six specimens of *Cryptobranchus* were taken from the Ohio river at Marietta, Ohio, in March, 1914, and kept in an aquarium. Within the next two months worms were found on four of the animals. They were threadlike, 15 to 25 cm. long, and whitish in color. The oldest individuals are little more than cuticular tubes filled with living young. These older worms protruded for varying distances from the skin of the host. Younger individuals did not protrude. The embedded portions of the worms were barely covered by the epidermis of the host. They caused a loosely sinuous, light colored elevation of the skin, the course and extent of which differed in each case. The worms were located at various places on the dorsal, lateral and ventro-lateral surfaces of the trunk, on the tail, and even on the head.

The more detailed description about to be given is based in large part upon the best specimen at hand which I shall hereafter refer to as the complete specimen. This worm is 20 cm. long. It has a practically uniform diameter of 0.53 mm. The anterior end is bluntly rounded

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(Fig. 1). The mouth is terminal. There is one dorsal and one ventral lip. These project anteriorly for 0.028 mm. and are roughly triangular, being 0.04 mm. wide at the base and 0.02 mm. wide at the tip. In the two oldest specimens I noticed two blunt hooks inserted in each lip. They appear as two parallel, refracting lines and may be followed to the base of the lip. In one of the two worms they protrude a very short distance from the tip of the lip. In the other individual they are retracted. In this condition it is hard to distinguish them because their refractive index is about the same as that of the lips. Inability to detect them in the other specimens is probably due to this cause. At the base of the lips the body is 2 mm. wide. It increases in width very rapidly up to a point 1 cm. towards the posterior where it is 0.53 mm. wide, which is the practically uniform diameter of the remainder of the worm. Near its posterior extremity the body tapers down rather suddenly to a diameter of 0.2 mm. which it retains for 0.3 mm. and then ends in a rounded point 0.075 mm. wide. The anus is terminal (Fig. 2).

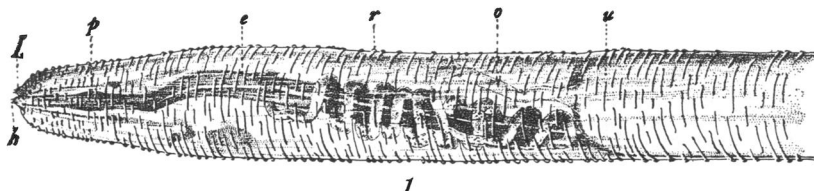


Fig. 1.—Optical section of the two anterior millimeters; *l*, lips; *p*, pharyngeal bulb; *o*, ovary; *e*, esophagus; *u*, uterus; *h*, hooks; *r*, ridges.

The cuticula is characterized by an embossment in the form of low, rounded, transverse ridges with bluntly rounded ends. These are confined to the dorsal and ventral surfaces, each area being 0.42 mm. wide and extending the length of the body. In a surface view of the worm the ridges are most evident along the sides of the body where they appear as lateral thickenings that project out 0.01875 mm. Elsewhere they are hard to discern unless the light strikes them at the proper angle. They vary in length, some of the shorter ones being 0.059 to 0.09 mm. long, and the longer ones 0.18 to 0.28 mm. The width varies slightly with the individual, those on the complete specimen having an average width of 0.033 mm. They are arranged end to end in rows with spaces varying from 0.0187 to 0.056 mm. between them. These intervals are usually overlapped by a ridge in an adjacent row. The space between rows varies from 0.037 to 0.075 mm. The embossment begins at the base of the lips in the form of rounded papillae-like elevations which become successively longer and more definitely aligned until at a point about 1 mm. from the base of the lips the previously described arrangement is attained. The ridges gradually become less

distinct on the narrow region at the posterior end of the body and the latter half of this region is smooth (Fig. 2). There is a smooth space on each side of the body 0.4 mm. wide which separates the dorsal and the ventral embossed areas throughout their extent (Fig. 4). At both ends of the body all these areas become proportionately narrower. Scattered over the surface of the lateral fields are a number of extremely minute, rounded papillae. Along both the dorsal and the ventral edges of each field 0.093 mm. distant from the respective embossed areas, there are some slightly larger papillae which are more or less regularly arranged in two rows. The papillae of one row alternate with those of the other. The distance between those of a row averages approximately 0.056 mm. The rows are about 0.037 mm. apart.

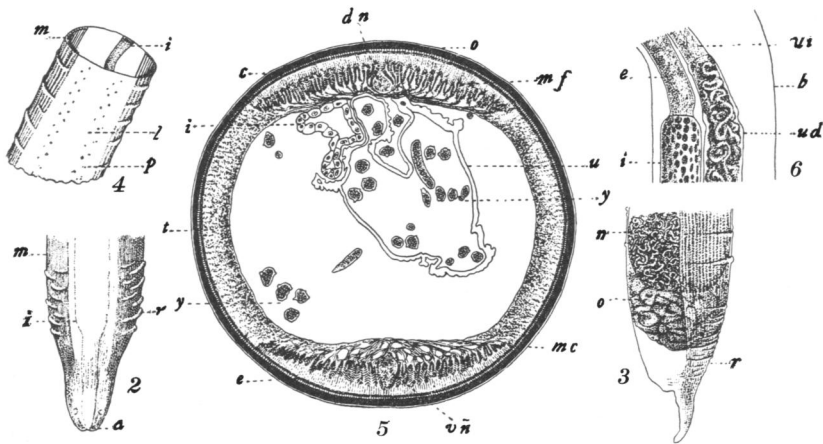


Fig. 2.—Optical section of posterior end; *a*, anus; *i*, intestine; *m*, muscles.

Fig. 3.—Posterior end of complete specimen; *o*, degenerate ovary; *r*, indistinct cuticular ridges.

Fig. 4.—Surface view of lateral field; *l*, lateral field; *p*, cuticular papillae in rows.

Fig. 5.—Cross section through uterus; *dn*, dorsal nerve; *vn*, ventral nerve; *mc*, muscle cell; *mf*, muscle fibril; *t*, intestine; *o*, outer layer of cuticle; *c*, inner layer; *u*, uterus; *y*, section of young; *e*, epidermis; *t*, tissue of lateral field.

Fig. 6.—Junction of esophagus with intestine; *e*, esophagus; *i*, intestine; *ud*, partially distended uterus; *ui*, immature uterus; *b*, body wall.

There are two layers in the cuticle, an inner layer about 4μ thick and an outer layer which is probably one fifth as thick (Fig. 5). In surface view of the lateral field two types of very fine striations are visible. One of them follows the circumference of the body and occurs at very short intervals. The other striations are, if anything, finer than the preceding and run diagonally. Separation of the two layers shows that the outer layer is homogeneous and that striations are in

the inner layer. This layer stains very deeply in Delafield's hematoxylin whereas the outer layer does not take the stain but has a slightly amber hue. Beneath the cuticula is a single layer of extremely narrow columnar epidermis cells about 0.018 mm. in height.

The alimentary tract is the nearly straight, approximately centrally located tube characteristic of the nematodes. In the complete specimen it is displaced by the greatly distended uterus and winds in long open spirals. There is a narrow pharyngeal tube approximately 0.375 mm. long in which at a point 0.26 mm. from the mouth there is a spindle-shaped bulbular enlargement. This is 0.15 mm. long and midway it has a maximum width of 0.11 mm. Anterior to the bulb the width of the pharynx is 0.055 mm. Posterior to the bulb the width is 0.11 mm. but it almost immediately widens out into the esophagus which may be said to begin 0.375 mm. from the mouth. The esophagus is 0.13 mm. wide and extends posteriorly for 15 mm. to the intestine. In cross section it is triangular. There is a sharp constriction of the esophagus at its junction with the intestine (Fig. 6). The intestine has an average diameter of 0.187 mm. It ends in a short rectum. In the complete specimen the lumen of the intestine is obliterated in both the intestine and the adjoining portion of the esophagus, but these structures lie free in the coelom. Further back the intestine is represented by a brown, flat band which adheres to the body wall. In the younger individuals the intestine is free and retains its tubular shape throughout.

The reproductive system consists of a uterus and two ovaries. As previously mentioned the presence of a vagina or a vulva is still in doubt. The uterus when fully distended with young entirely fills the coelom with the exception of 2.7 mm. at the anterior end and 0.56 mm. at the posterior end of the body. Its wall is approximately 0.0042 mm. thick. In the less mature individuals the uterus is only partially distended. This is particularly well shown in a specimen in which the distention begins 15 mm. from the anterior end of the body. The distended portion is only 0.2 mm. in diameter and anterior to this it decreases to 0.09 mm. within a distance of 0.2 mm. The young in the enlarged region are the size of those in the complete specimen but in the zone between the narrow and the distended regions there are extremely small young.

The young average 0.33 mm. in length and 0.014 mm. in width. Their anterior end is blunt; the posterior one-fourth of the body tapers rapidly into a sharp hair-like point. I saw none enclosed in a capsule although many of them were coiled. In most parts of the uterus they maintain a constant wriggling, but in places they are so tightly packed as to leave an impression on the body wall. Individuals liberated in tap water retained their activity.

At each end of the uterus there is a single, slender, tubular ovary. The anterior ovary of the complete specimen begins 1.12 mm. from the anterior end of the body and runs posteriorly in a series of coils about the esophagus to the uterus. It then extends forward slightly beyond its point of origin and then again turns back and joins the anterior end of the uterus which is 1.59 mm. from the anterior end of the body. The diameter of the ovary at its tip is 0.056 mm.; for the greater part of its extent it is 0.09 mm.; and at its junction with the uterus 0.11 mm. The posterior ovary in the complete specimen has degenerated and is represented by an irregular mass of tissue.

The muscles are restricted to two broad bands, one dorsal and the other ventral, each corresponding in extent to the dorsal and the ventral embossed areas of the cuticula. In the mid-dorsal and the mid-ventral lines each band is interrupted by a nerve cord. In a surface view of the animal the muscles give the effect of longitudinal corrugations (Fig. 3). In cross sections of the body 36 muscle cells are distinguishable in each band, there being 18 on each side of the median line.

In the material at command no excretory tubes can be distinguished, but I hesitate to deny their presence entirely. The lateral field, where such tubes are usually found, is occupied by an apparently homogeneous mass of connective tissues of a rather loose texture. This field has a width of 0.14 mm., or practically one-fourth of the circumference of the body.

The nervous system was also only partly distinguishable. There are two longitudinal nerve cords, one in the mid-dorsal and the other in the mid-ventral line (Fig. 5). I could not determine the nature of the anterior termination of the cords in any of the worms because of the poor histological condition of the sections in this region.

There are some stray notes regarding the life history which may be of interest. As stated before, the worms are viviparous and the young can survive in water. They are apparently liberated by the disintegration of the parent's body. In two of the worms that portion which protruded from the host had been attacked by a fungus and was so far disintegrated that the body barely remained intact. Young worms which had broken out of the uterus were crowded into the coelom of this region. It is an interesting fact that among the two lots of *Cryptobranchus* which I have had under observation there have been no specimens which showed signs of infection when they were received. Both lots were taken from the same place at the same time of the year, although one lot was taken a year later than the other. In both cases signs of the parasites were observed about a month after their hosts had been caught. At this time the worms caused an almost imperceptible thread-like elevation of the skin. A month later in each case the parasites were clearly visible and had apparently about reached

the end of their growth. Both lots had been kept in filtered water although the supply in each case was from a different source. The young parasites probably entered the skin of their hosts during the summer from the water in which the latter lived.

The percentage of the individuals infested must be very great since of the two lots which have come under my observation, there being six specimens in one and four in the other, all but two of the individuals harbored one or more of the parasites. Apparently the presence of the parasites is a matter of no concern to the host. There are no evidences of injury or of disturbance in the tissues other than the narrow tube formed in the epidermis of the host. The inner lining of this tube glistens and is smooth except for slight indentations made by the cuticular ridges on the parasites.

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